REDUCING MALARIA BY REDUCING THE NUMBER OF ANOPHELES WITHIN BUILDINGS.

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Malaria may be entirely eliminated and in time become an unknown disease. But to achieve this desired end soon, calls for unprecedented co-operation extended over a very large territory, and it would require vigorous anti-malarial work for many years. The cost of such work will be very heavy, however, an investment as great, if not greater, than the Panama Canal. The lives and time saved by such eradication, and the increase in energy and longevity which would follow, expressed in dollars and health, would soon repay with interest all that had been spent. A campaign such as this could, with very little additional cost, eliminate a few of the other insect-born tropical diseases.

The purpose of this paper is to show how in a given camp malaria may be greatly reduced by the reduction in numbers of the *Anopheles* which gain entrance into buildings. By *Anopheles* I mean those species only which are known to or are supposed to transmit malaria. It is essential, therefore, to become acquainted with the mosquito fauna of a given region and learn which members of it are pathogenic. The observations recorded herein were made at MiraFlores construction Camp, Canal Zone, at which point are the last two flights of locks to the Pacific entrance. The buildings of this camp are of similar size and shape, located in straight, parallel rows. This uniformity in design and position made the interpretation of our data easy. The following sketch aims to give all the essential data regarding MiraFlores camp. All doors are indicated excepting such as lead only to screened-in porches. The symbols used signify: W-I—West Indian negro; S—Spaniard and other European; C—Columbian and Panamanian; E-I—East Indian (Hindoo); W—white American. Unmarked buildings are offices, stores, schools, hotel, police station, etc. Dots represent position and number of insect traps affixed to the buildings. All doors, windows, etc., are well screened with 18-mesh copper wire screen, and cracks and holes in floors are stopped-up as well as

could be expected. The site of the camp is at present under the waters of MiraFlores Lake. The observations reported were made in the year 1912. I am indebted to Messrs. Shropshire and Chiddester for aiding me considerably at this station.

There were only five possible sources for extensive *Anopheles* breeding, and regular (almost daily) inspections were made of the entire territory to locate *Anopheles* breeding. The only *Anopheles* found to be predominant in the mosquitos caught in the camp was *A. albimanus* Wiede., and excepting during the dry season (Jan. to Apr.), when *A. pseudopunctipennis* Theob.

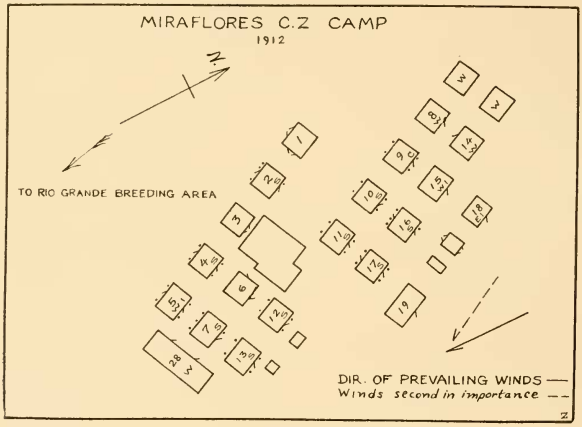

FIGURE 1

appeared in sparce numbers, was practically the only Anophelene represented in these catches. During the first six months of 1912, only one *A. apicimacula* D & K, one *A. argyritarsis* Rob-Desv. and two *A. malefactor* D & K were caught. The only extensive breeding of *A. albimanus* occurred in the winding Rio Grande, south-west of MiraFlores camp. The five possible breeding centers were: 1, Rio Grande; 2, Rio Cardinas; 3, Rio Cameron; 4, Cocoli water reservoir, and 5, the ditch in the Canal Prism. During the dry season the Cameron river was an unusually favorable habitat for *A. pseudopunctipennis* and *Uranotænia geometrica* Theob., but no influx of these species was ever noted in MiraFlores. By means of liberating

at these and other stations mosquitos sprayed with aquaeous anilin dyes, it was determined that the big influx of *albimanus* came from the extensive breeding area in the Rio Grande. The data concerning flight is reserved for a future report.

Exact counts were made of the mosquitos caught in traps and inside of houses; these counts are differentiated as "trap catch" and "hand catch" respectively, and are further divided into two groups, "Anopheles" and "Culex spp," the latter representing all non-anophelinæ. All counts were made daily, but in the results presented in this article, this data is greatly simplified. The trap catch represents those mosquitos which entered the Chas. H. Bath type of insect trap affixed to buildings. This trap is described in my previous paper (Ann. Ento. Soc. Am. vol. VI No. 1). These traps were placed on the sides facing S-W and N-E. The method of catching mosquitos inside of barracks is also described in my former paper. Although the cheapest labor was used, W. I. negroes, this work could hardly have been done better.

EFFECT OF TRAPS AFFIXED TO BUILDINGS ON THE NUMBER OF MOSQUITOS WHICH ENTER THE BUILDINGS.

Two buildings were used to determine this influence. The following table gives a comparison of these two buildings:

Camp 5.	Camp 15.
Contains 75 W-I negroes.	Contains 75 W-I negroes.
Two doors opening to exterior.	But one door opening to exterior.
Four traps.	No traps.
Nearest to breeding area.	Farthest away from same.
Of total mosquitos caught in both camps, this camp's share was but 33%.	Of this same total, this camp claimed 67%.

This comparison shows that both buildings are practically the same, excepting that one has traps while the other has none. The building farthest away from the breeding place, and with but one door, had 67% of the total mosquitos caught in the two camps.

The record was kept of the cases of malaria reported from each of these camps. During the 175 days representing this record, 29 cases came from camp 15 (without traps) and but 12 cases from camp 5. It may be said that there is no conclusive proof that these cases had their origin from the mosquitos present inside of the barracks. But granting this, it surely

appears that in two camps so nearly alike we ought to expect about the same number of cases in each. The increase of 250% in camp 15 is due to the fact that on account of no traps, more mosquitos entered the building, and therefore the higher malarial rate.

The weekly summary for these two camps is represented in the following chart. The weekly index was gotten at in the following manner. If during the week twelve collections were

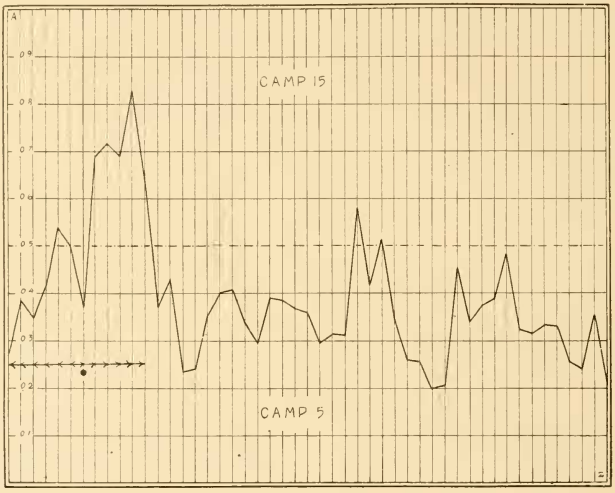

Chart A

made in camp 5, then the total mosquitos (anophelene only) caught in that week were divided by twelve. This gave an average per one catch per week. The same was done with camp 15. Then the average catch of both camps for the same week was added together and considered as 100%. The following notes should be read in connection with the curve. That portion of the chart included within the series of arrows represents data for camps 5 and 10 for during that time camp 10 was used as a W-I barrack. Both camps had four traps each, but camp 10 had but one door while camp 5 had two. Very often extreme fluctuations are due to existing cracks in the floor

through which Anopheles may enter. This is well illustrated by the behavior of the curve at the point marked by a black disc. At this period all cracks in camp 10 were stopped-up. Note the sudden up-shoot of Anopheles in camp 5 due to this. Up to this period the cracks present in camp 10 were the equivalent of an extra door. The remainder of the chart is for camps 5 and 15, and the curve is almost as significant as the familiar campaign literature advocating vaccination against small-pox.

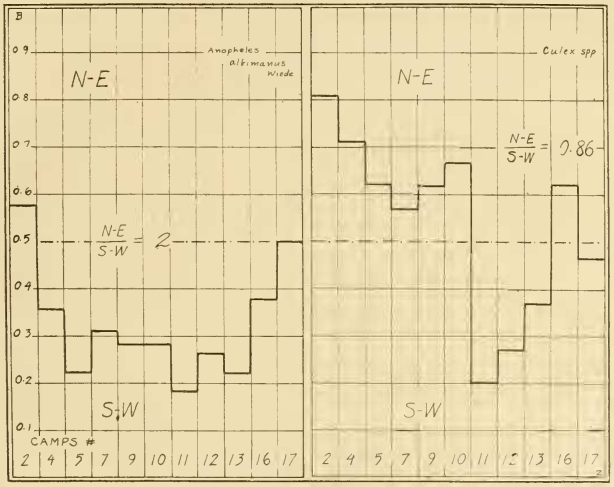

Chart B

PECULIARITIES OF TRAP CATCHES.

Eleven of the buildings of MiraFlores camp had insect traps attached to them. Chart B presents a comparison of the trap catch of the north-east and south-west sides of each building. The percentages were arrived at the following manner: the total number of *Anopheles* caught during the nine weeks from Jan. 29 to Mar. 30, 1912, in the S-W traps were divided by the number of traps to give an average per trap. The same was done for the N-E traps. The total of these two averages in each building was taken to represent 100%. The record for each building was differentiated into *Anopheles* (almost wholly *albimanus*)

and Culex spp. (non-anophelinæ). The Anopheles curve shows double the number of these mosquitos in the N-E traps. There appears to be no discrimination as to nationality of the inhabitants of the several buildings. Emphasis is placed upon the fact that north-east traps contained the bulk of the anophelenes. Reference to the map shows the relation of wind direction to position of traps. The *Anopheles* did not enter freely the S-W traps because this entailed flying against considerable wind. The bulk of these mosquitos flew around the lee side and entered the N-E traps. This preference for the lee side of houses was noted in every case where traps were present. It therefore follows that entrances to buildings should always be on the windward side and not on the lee side.

The culex curve shows conditions opposite to that for the anophelenes. There is no doubt whatever that the culex breeding in the caison to the west of the camp supplied the influx of culex, and being more powerful fliers, did not find themselves forced to seek a wind-protected side. I have no positive evidence of actual flight or even gradual infiltrations of culex from the Cameron River northeast of the camp.

PECULARITIES OF THE HAND CATCH DUE TO NATIONALITY OF THE INHABITANTS.

At first thought it appears improbable that the particular nationality may influence the number of mosquitos that gain entrance into the building. The following table is presented to show what influence was observed at MiraFlores camp.

TOTAL PER FOUR WEEKS' PERIODS, HAND CATCH.
(Avr. per one camp, 1912.)

FOUR WEEKS ENDING	SPANIARD	COLUMBIAN	WEST INDIAN	EAST INDIAN	TOTAL
February 24	459	959	477	75	1970
March 23	434	892	357	42	1725
April 20	486	1274	353	31	2144
May 18	2321	3252	1781	410	7764
June 8 (Only 3 weeks)	1140	2724	1453	422	6139
AVERAGE PER DAY, SAME PERIODS AS ABOVE.					
	20.	34.3	20.5	2.7	77.5
	19.	32.	12.7	1.5	65.2
	17.4	45.5	12.7	1.1	76.7
	83.	116.	63.6	14.6	277.2
	54.3	129.7	69.1	20.	273.1

All barracks were of about the same size, type, and held about the same number of people each. Yet the Columbian camp had a much larger percentage of mosquitos than any other camp, and were it not that it had four traps, the amount of mosquitos would more than be double. To understand this pecularity, it is necessary to understand the peculiar behavior of these several types of people, and I briefly outline the more important of these peculiarities. The Spaniard as a rule prefers to lounge outdoors until quite dark. The door to his barrack is practically closed during dusk, the period of maximum mosquito (anophelene) activity. The West Indian is much like the Spaniard in this respect. The Columbian, on the other hand, is much more restless, goes in and out of his camp during the hours of dusk with much frequency and often leaves his doors wide open. The East Indian stays inside of his barrack almost exclusively. Therefore the entrance to his home is kept closed most of the time. Constant opening of doors during the period of dusk, particularly doors on the lee sides of buildings, will admit large numbers of malarial mosquitos.

The malarial rate for the four types is given in the following comparative table.

Malaria Statistics, January 2 to April 27, 1912.
(17 Weeks.)

A. Population.

Spaniards	503
Columbians	60
West Indians	102
East Indians	47

B. Malaria Data.

	Total Cases	Avr. Num. per Week	Num. per 100 Sick per Week
Spaniards	153	9.2	1.85
Columbians	11	0.7	1.18
West Indians	44	2.6	2.55
East Indians	2	0.1	0.21

The East Indian (hindoo) is the one with the least malaria, due not to immunity, but becasue of his habit of staying indoors during dusk. Economically considered, the hindoo is the least expensive type of labor, considering cost of hospital treatment. The Spaniard and West Indian, roaming outdoors during dusk, when anophlenes are most active, and being quite susceptible to malaria, show the biggest percentage of cases. The Columbian, native of the region and a veteran

of malarial attacks, although his camp has the most malarial mosquitos, shows less fever than the Spaniard. This low percentage is due to a partial immunity "earned" through several previous attacks. I mean by partial immunity more particularly the absence of high fevers; the majority of the laborers whose blood teems with crecents but have no fever, do not present themselves for treatment. Only those cases which come to the office of the District Physician enter our statistics. Another interesting peculiarity is observable; although the Spaniard is more susceptible to malaria than is the West Indian, his rate is lower. This is due to the fact that the Spaniard makes liberal use of the liquid quinine freely dispensed at the messes and places of work, thus reducing and eliminating much malaria. The Spaniard looks upon malaria as just so much money lost; the West Indian is of a much livelier nature, not caring if he is losing money.

No few cases of malaria among the West Indian are repetitions, i. e., a recurrence of the fever after the patient left the hospital. Our hospitals cannot take care of malarial cases for a period longer than after the fevers subsided and the blood smears reveal no crecents or but a few. The patient is always advised to continue quinine treatment for at least a month after dismissal. It should be made clear that the figures presented are for the dry season period, and do not include the high increase in malaria from May to November, and hence may be considered as true indexes of actual susceptibility.

SUMMARY.

The observations reported are applicable largely to temporary construction camps in malarious regions, and unless permanent settlements are in view, screening, traps and mosquito catching indoors will suffice to keep malaria at a very low rate. However, a certain amount of control work must always be done at larval habitats of the mosquitos. The degree of such anti-malarial work (ditching, fills, etc.,) will depend entirely upon whether the locality is to become a permanent settlement, or whether that locality, if untreated, would prove a serious menace to other localities.

Traps should at first be placed on all four sides of buildings to determine which side attracts the most mosquitos. Our

data indicates that the *Anopheles* of Panama enter largely the traps on the lee sides of buildings. Probably this holds true elsewhere, but this fact should be determined at each new locality. Doors should be on the windward side of buildings, and they should be opened and closed as little as possible during dusk, the period of maximum *Anopheles* activity.

Houses should be well screened with 18-mesh wire screen, and all cracks, holes and openings in walls or floors must be stopped-up.

Mosquitos within buildings should be caught and killed daily. The best method is to use a killing tube such as described in these Annals, p. 16, vol. VI. A satisfactory scheme is to darken all windows but one, and to catch the *Anopheles* which go to the undarkened window. The time for such collections is at early dawn.

Ancon, C. Z., June 10, 1915.